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THE WISCONSIN COASTAL MANAGEMENT PROGRAM, part of Wisconsin Department of Administration, and overseen by the WISCONSIN COASTAL MANAGEMENT COUNCIL, was established in 1978 to preserve, protect and manage the resources of the Lake Michigan and Lake Superior coastline for this and future generations.

The Project Team

This project required coordination and completion of several steps including map documentation, photo preparation, photo interpretation, digital area/linear measurement and data sheet preparation. The following students worked as a team to help complete this project.

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Assessing Coastal Development Along Wisconsin's Great Lakes Shoreline: 1978 - 1992

Coastal Management Program Contract No. 840005-501.15

INTRODUCTION

The Wisconsin Coastal Management Program mission includes developing an understanding of change along the state's Great Lakes shoreline. Such change, of course, can be natural or human-based. This study was undertaken to document natural and human-based development within the coastal zone of the state's Lake Michigan and Lake Superior shorelines. The Wisconsin legislature has defined coastal zone as land within 1,000' (304.8 meters) of the shoreline (Ordinary High Water Mark - OHWM).

Future coastal zone planning and risk assessment requirements defined the types of data to be collected. Assessment of risk to structures built in the coastal zone requires a temporal analysis of structural development and shoreline modification(s). Planning of the coastal zone requires, as well, determination of the natural resource base. This study utilized U.S. Army Corps of Engineers historic color aerial photographs taken in 1978 and 1992.

This report documents both the original and amended contract to assess natural and developmental change within the coastal zone of Wisconsin's Great Lakes shorelines. Although the original contracted work was interrupted to include elements of the amended contract, no attempt will be made in this report to keep separate original vs. amended objectives, procedures or results. Goals of the amended contract include and expand those of the original.

PROJECT GOALS

Planning and assessment of hazards within the coastal zone defined the goals of this study. Within the Lake Michigan and Superior coastal zones, project goals included:

- Development of land use databases for 1978 and 1992
- Development of 1978 and 1992 databases of human modification of the shorelines
- Develop a database of built structures for 1992 Additional goals included:
 - Assess land use change within the coastal zone from 1978 to 1992
 - Assess human modification of the shoreline from 1978 to 1992

STUDY AREA

The project study area comprises the Wisconsin portion of the Lake Michigan and Lake Superior coastal zone (Figure 1). In 1982, the Wisconsin state legislature defined coastal zone as being that land within 1,000 feet (304.8 meters) of lake shoreline. Accordingly, the study area represents a 1,000' wide

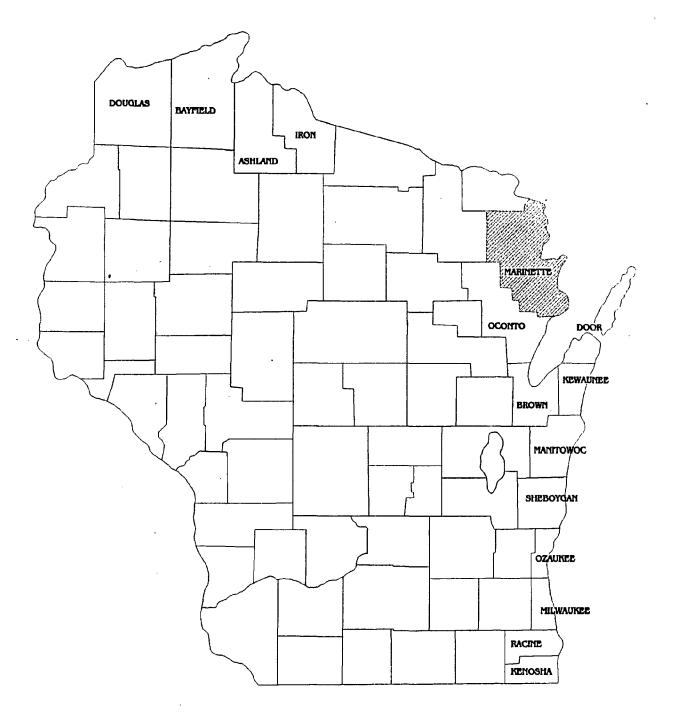


Figure 1. Coastal Counties of Lake Michigan and Lake Superior

zone, the landward boundary of which is parallel to the coastline.

PROJECT METHODS

Aerial Photography

Using aerial photos to assess coastal development requires clear statement of goals, appropriate definition of coastal zone, meaningful classification scheme, appropriate historical and current aerial photos, appropriate interpretation procedure and method of documentation, and trained personnel.

Application of aerial photography to assess urban and natural resource features is documented well (Smith, 1968; Avery and Berlin, 1985; Lo and Noble, 1990; Ciciarelli, 1991; Boge et al., 1992; Hinckley and Walker, 1993). Specific applications to urban/human activities cover a wide range including urban nonpoint pollution assessment (Kim and Ventura, 1993), gully erosion analysis (Welch et al., 1985), historical analysis of urban development into coastal wetlands (Niedzwiedz and Batie, 1984), identifying structural additions to urban residential property (Niedzwiedz, 1990), and studying agricultural land use (Marsh et al., 1990).

Aerial photos have been used to map archeological sites, urban features, and to document changes to the landscape (Smith, 1968). MacConnell (1975) reports the use of black and white aerial photography (scale 1:20000) to map 20 years of land use change within the state of Massachusetts, including the coastal zone. As part of a larger Great Lakes study, the International Joint Commission (1993) used 1:24000 scale photos to map land use features along the Berrien County, Michigan segment of the Lake Michigan shoreline. Results of the photo analysis were used to assess residential riparian erosion/recession rates caused by fluctuating water levels.

Wisconsin's coastal zone includes diverse land use, from forests and wetlands, to land devoted to agricultural or urban uses. The uses of aerial photos long have been applied to study such land uses. Befort and Viliman (1985) studied aerial photos to classify forest habitat. McCarthy et al. (1982) evaluated spruce-fir forests to aid management. Wetlands analysis is possible with aerial photos of appropriate format, scale and seasonal timing. Scarpace et al. (1981) used digitized aerial photos to map wetlands, while Ferguson et al. (1993) and Barrett and Niering (1993) have monitored sawgrass habitat and marsh vegetation change using aerial photos.

Extensive use of aerial photography has been directed at coastal resources. Scherz and Van Domelsen (1973) used aerial photos to help assess water quality in Lake Superior near Duluth, Minnesota. Numerous studies have been made with aerial photos to aid management of coastal resources (Benton et al., 1978; Hill et al., 1985; Norton et al., 1985; Welch et al., 1992), to address change in coastal wetlands (Lyon and Greene, 1992), and to

examine urban development into coastal wetlands (Niedzwiedz and Batie, 1984).

Project Aerial Photos

In 1978, the U.S. Army Corps of Engineers (USACE) obtained panchromatic color aerial photos of the Wisconsin portion of the Lake Michigan coastline. In 1992, USACE obtained color aerial photo coverage of the Wisconsin portion of both Lake Superior and Lake Michigan coastlines. Both the 1978 and 1992 photos were flown at a scale of 1:6000 (1" = 500') and enlargements made at 1:2400 (1" = 200'). The 1978 photos were taken April 16th. The 1992 photos were flown May 13th.

Unlike most historical aerial photos covering the same area and flown at the same scale, the USACE photos of 1978 and 1992 were not flown with coincident photo centers or coverage. No individual flight lines were documented for the 1978 photos. Beginning at the Michigan border, the 1978 photos were taken incrementally to the Illinois border. Photos are documented with the photo date and photo number on the northern edge of each photo.

Flight lines were documented for the 1992 photos. Flight line #1 begins just south of the Wisconsin-Illinois border. The northern edge of each 1992 photo displays the photo date, flight line and photo number.

Both the 1978 and 1992 photo contact prints (1:6000) were flown to produce stereo coverage of the coastline. Adjacent photos overlap (endlap) about 60% with each other. The enlarged photos (1:2400) available for this study represent every other photo contact print, therefore, only photographic, not stereo coverage, is provided by the enlarged photos. Approximately 1,800 photos (1:2400) cover Wisconsin's Lake Michigan shoreline, 900 for each flight year. About 1,200 photos covering the shoreline from Marinette to Sheboygan are on file at the Green Bay office of USACE. The Waukesha office of USACE has on file about 600 photos covering the shoreline from Sheboygan to the Illinois border.

Photo Preparation

Photos used in this study are owned by USACE. As a result, all photo documentation and interpretive work was applied to acetate affixed to each photo. Preparing photos for interpretation included the following:

- 1. Affix label and document photo number/flight line, photo date and Public Land Survey System (PLSS) information.
- Mark photo fiducials (orange ink). Fiducials allow the registration of acetate overlays to the photos, if required.
- 3. Mark control points (orange ink). Typically these points are road intersections and, or buildings, stable objects

that could be referenced against controlled maps for future mapping applications.

- 4. Locate and mark interpretation boundary lines (black ink). These lines are used to denote a common boundary between adjacent photos. Land use interpretive lines end at these boundary lines, which eliminates redundant interpretive work.
- 5. Locate, mark and label PLSS section lines (red ink).
- 6. Locate, mark and label civil boundary lines (green ink).
- 7. Locate and mark 1,000' coastal zone boundary line (blue ink). A divider was used to scribe a line 1000' away and parallel to the line defined by land meeting water. In cases where large streams entered Lake Michigan, a straight dashed line was drawn to represent a continuation of the shoreline.
- 8. Locate and mark top of bluff, and bottom of bluff if slumpage is evident (black ink). In practice, these lines were not drawn until the shoreline portion of the classification scheme was applied to the photos. Refer to the section Photointerpretive Process (page 11) for additional discussion.

Aerial Photo Interpretation (API)

The landscape within the coastal zone can represent a complex mix of natural to urban uses. The land use classification scheme developed for this study addresses the complexity of Wisconsin's coastal zone. The scheme is a modification of the scheme developed by International Joint Commission (1993) and includes the general use categories of residential, commercial, industrial, transportation, extractive, agricultural, natural, open land and other uses. Land uses have been measured by area (acres, hectares). Structures per land use have been located and marked for spatial reference. Structures are tallied by type for 1992.

Modification of the shoreline also has resulted. Sea walls, revetments, groins and permanent docks have been constructed. Sea walls and revetments are linear types. Their interpretation and measurement are presented in feet (meters). Groins and docks were counted.

CLASSIFICATION SCHEME

Residential Land

All residential areas include infrastructure to service the area. Boundary placement is made to separate residential areas by type. No attempt is made to distinguish roads/streets from the residential areas they serve. This convention is true for other classification types as well.

- 111 Multi-Family: Medium to High Rise. Large residential structure of five (5) or more stories. Access roads, parking areas, open space and recreational facilities associated with the structure(s) would be included in the type.
- 112 Multi-Family: Low Rise. Large residential structures up to four (4) stories. Access roads, parking areas, open space and recreational facilities associated with the structure(s) would be included in the type.
- 113 Single Family, Duplex. Structures large and small used for residential use. The type includes lawn, landscaped areas, garage and driveways. Duplex structures are identified by twin driveways or a very wide driveway leading to an architecturally balanced structure.
- 115 Mobile Home Park. Residential area developed exclusively for mobile units.

Commercial and Industrial Land

Commercial land includes three (3) types: central business district; shopping center/mall; and, neighborhood business district. Each type includes all building structures, access roads/streets, parking facilities and other features commonly associated with each type.

- 121 Central Business District (CBD). Commercial land predominantly used for distribution or merchandizing of goods and services. Stores, hotels, office buildings, parking facilities and smaller warehouses constitute the components of this type. The CBD spatially is tight, vegetation is rare.
- Shopping Center/Mall. These commercial areas have developed away from the CBD. The type includes both "strip" type development and malls. Structures can range from large, flat roofed and rectangular (centers) to large, geometrically shaped. Both types include large parking areas adjacent to or completely surrounding the commercial structures.
- Neighborhood Business District (NBD). This type denotes small commercial areas within, or adjacent to residential areas. The type may be found in established or newer subdivision areas. NBD structures can range from conventional architecture to unusual geometric shapes. Small parking areas are associated with NBD commercial areas.

126 Institutional Land. The type reflects areas devoted to public or quasi-public uses. Examples include schools, churches, hospitals, prisons, etc., and their associated "grounds," green space, landscaping and parking facilities. When located within the CBD, public buildings without "grounds" often cannot be identified on aerial photos and would be classified as commercial (121).

Industrial Land

138 Industrial Park. The type includes both heavy and light industrial use areas.

Heavy industrial land contains facilities for the manufacture, storage and assembly of raw or partially processed products such as machinery, metals, chemicals, petroleum, or electrical power. Such industries often have large smokestacks and large storage areas. Warehouses and transportation facilities for bulk products and an open and interrupted street pattern characterize this type.

Light industrial land contains facilities for the manufacture or assembly of smaller, partially processed products such as electronics, appliances, and other secondary process products. Large smokestacks or raw material storage facilities are never present. Many modern light industries are well landscaped and are indistinguishable from commercial activity on aerial photographs.

Transportation Land

- 141 Air Transportation. Includes areas with airports and associated facilities, landing strips, hangers, parking areas and adjacent open areas.
- 142 Rail Transportation. This type includes railyards, terminal freight and storage facilities as well as stations for passengers. The type may include liquid storage facilities such as tank farms.
- Water Transportation. This designation is applied to several water-based areas, including docks, warehouses and related land-based facilities for water transportation and commercial fishing. The type includes, as well, public marinas and their associated facilities: boat slips, buildings and parking areas.
- 143.1 Private Marina. Boat mooring areas adjacent to residential land are designated as private marinas. Often such areas include a protected slip(s), dredged waterway and, or a permanent docking structure built into the waterway.

- 143.2 Public Boat Landing. This type is applied to boat launching areas. Typically, facilities include only a ramp(s) from which boats may be launched and parking areas.
- 144 Divided Highway. This type includes transportation corridors with median strips between lanes. Typically, such roads are four or more lanes wide. Local streets are not included in this type.
- 145 Communications. Facilities and structures devoted to communications. These include radio/television towers, lighthouses and their grounds, buildings and parking areas.
- 146 Utilities. This type includes facilities for the production and distribution of energy. Such areas can include large buildings, towers, roads/parking facilities and, in the case of coal fired plants, large piles of raw coal.
- 147 Sewage Treatment Plant. Buildings, treatment lagoons, parking areas, access roads and grounds are included in this type.
- 148 Landfill. Landfill sites used to bury garbage define this type. Landfills cover an extensive area and are dominated by large excavated areas, mounds of exposed soil and access roads.

Extractive Land Use

- 171 Open Pit. The type represents open pit mining areas for extraction of sand, gravel, stone or rock. The type includes access roads and any structures.
- 172 Underground Mine. Mining of underground resources via shaft extraction. Surface features captured on aerial photos would be limited to small structures and access roads.
- 173 Well. Features associated with wells are limited. Identification of wells using only aerial photos is difficult.
- 179 Other Extractive Uses.

Agricultural and Natural Land

Abandoned Field (AF). These are agricultural units reverting to wild land. Woody vegetation and grass are abundant but tree crown cover is less than 30%. If tree crown cover were greater than 30%, the land would be classified as forest.

- 182 Agriculture Active (AG). Tilled or tillable crop land which is or recently has been intensively farmed. The boundaries on the ground usually are sharply defined and well maintained. The land supporting farm buildings is included as part of this type.
- 183 Forest (F). Areas of forest, deciduous, coniferous or mixed, having canopy closure of at least 30%. Areas with less than 30% canopy closure are classified as abandoned field.
- 184 Heath (H). Areas of heath plant community as well as grass, shrubs, and other low vegetation found on poor sandy soils.
- Open Water (W). Areas of open water found in lakes, rivers and large streams. Water depth is greater than three feet during the growing season. The boundary of coastal water is located by drawing a line at the river mouth to connect the edges of the coastline, or man-made features like roads, railroads or bridges crossing rivers or inlets are used to establish such a line.
- 186 Rock Ledge (RL). Rock outcrop areas at the coastline or within the coastal zone. Such outcrops are common in Door County.
- 187 Slump Zone (SL). Land located between upland bluff and beach. Slump zones begin at the bluff line and slope down to the beach.
- 188 Wetland (WT). This type covers the full spectrum of wetlands. These include seasonally flooded flats, shrub swamps, meadows, bogs, shallow and deep marshes, and forested wetlands. Each is described below.

<u>Seasonally flooded basins or flats</u> occur principally on stream floodplains. The most common plants are grasses and herbaceous species. The soil is waterlogged or covered with water during spring freshets, but well-drained during the growing season.

Shrub swamps often have waterlogged soil during the growing season, as much as six (6) inches of water may be present. Vegetation types include elder, buttonbush, dogwood and willow. Sedges usually are present in tussocks.

<u>Meadows</u> are vegetated with grasses, rushes and sedges. Soils are waterlogged through most of the growing season. Surface water is present only for a short period during the spring.

Bogs are unique wetland types that support a distinctive plant community, including most of the following: heath shrubs, cranberries, pitcher plants and sedges. Scattered black spruce, tamarack and red maple may be present. A mat of sphagnum moss is the most common feature of bogs.

Shallow marsh is wetter than meadow. The soil is completely waterlogged and often covered with up to six inches of water during the growing season. The predominant vegetation is emergent, including such plants as cattails, bulrushes, burreed, pickerelweed and arrowhead with some grasses and sedges present. The type is common to open water bodies.

<u>Deep marsh</u> has water depth ranging from six inches to three feet. Fairly large open water areas are bordered by, or interspersed with, emergent vegetation like that found in shallow marsh. Floating and submergent plants such as water lilies, duckweed, watershield and pondweeds also are present.

<u>Forested Wetlands</u>. This type represents areas of moist to saturated soil covered by forest canopy. The type is difficult to identify without stereo photography and, or with "leaves-on" photography.

Open and Other Land

- 191 Outdoor-Public Assembly
- 192 Urban Open Lots. Urban open is undeveloped land lying idle in the midst of urban areas or adjacent to them. This type includes land which has been cleared for urban development of an unknown use.
- 193 Outdoor Recreation. Outdoor recreation types are either mainly for participation, mainly for spectators, or are environmental in character. Each recreational type includes the recreational complex: access roads, parking facilities, buildings and other related facilities.
- 194 Cemeteries

Shoreline Modification

Development along the lakeshore often means modification at, or near, the shoreline. Land along the lakeshore is exposed to significant erosional forces. Recession of land mass is common. Agricultural and urban land uses destabilize shoreland, in effect accelerating erosion and land recession. To protect real estate and property, many property owners have constructed walls or revetments along their shoreline. Some owners also have built non-flow-through docks at the shoreline to provide mooring and protection for their boats. Groins, large rock structures perpendicular to the shoreline, have been built along Wisconsin's Lake Michigan shoreline.

195 Sea Walls (V 195 V). These structures are built parallel to the shoreline and typically are well defined, linear

features. Construction materials can include concrete, wood or interlocking sheet steel.

- 196 Revetments (<u>V 196 V</u>). Large rock or slab structures built parallel to the shoreline. Interpretively, revetments are less well defined, and appear wider than do sea walls.
- 197 Groins (* [red]). Groins are large rock structures built perpendicular to the shoreline into the water. Except for their distinct orientation and placement, groins appear similar to revetments.
- 198 Non-Flow-Through Dock (* [blue]). Such docks are permanent structures built into near-shore waters.

 Typically these docks are straight, their upper surface wide and well defined.

Structures - Industrial, Commercial and Residential

On the 1992 photos, buildings within the coastal zone are classified by type and location. Using a template of rectangles, for each building, a rectangle is selected that best represents the area of the building's "footprint." The selected rectangle then is positioned so that the leading edge of the building (relative to the shoreline) is located. Buildings for 1978 were counted by type. However, due to photo format differences, comparison of 1978 and 1992 structural counts may be inaccurate.

THE PHOTOINTERPRETIVE PROCESS

After photo preparation, each photo was interpreted using the classification scheme defined above. Area (land uses), linear (shoreline modification) and point (urban structures, groins, docks) types are represented in this study. Lines and, or symbols were used to define all types. Area types are represented by perimeter boundary lines and symbols to define and identify the areas. Line types representing modification to natural shoreline were defined using both lines and symbols. All area and line type symbols are recorded in black ink. Point types are defined by symbols and colored ink (see above).

Modifications to the shoreline, such as sea walls or revetments, are delineated by placing (painting) the 'V' symbol at the beginning and end of the modification. The type of modification is represented by placing the appropriate number between the 'V' symbols. For example, 195 positioned between two 'V' symbols means that a sea wall has been built along this section of shoreline. Shoreline classification was conducted before land use so that land use boundary lines placed along the shoreline would not 'hide' shoreline information.

Groins and non-flow-through docks were defined by point symbols (see above). In both cases, the symbol was placed at the point where the structure meets land. As discussed above, for

1992, buildings also were classified using point symbols. The delineation of buildings represents the last API procedure.

MEASUREMENT OF AREA, LINE AND POINT TYPES LOCATED WITHIN THE COASTAL ZONE

Area types (land use polygons) and line types (shoreline modification) measurements were made using the hardware/software facilities of the GIS Lab at the University of Wisconsin-Green Bay. Photo acetate overlays were affixed to large-format digitizers and each land use polygon digitized along the perimeter. Measurements recorded in square inches were converted to acres/hectares. Line measurements (in inches) of shoreline modifications were made using digitizers as well. Linear inch measurements were converted to linear feet/meters for each type of modification.

Point types (groins, structures) simply were tallied by count for each type. The area covered by each acetate was broken into civil jurisdiction and PLSS section designations.

Measurements (above) were separated by civil and PLSS designations as well, and documented permanently on each acetate overlay.

TALLY OF DATA

Measurements recorded on each photo acetate were transferred to data sheets. Three (3) levels of data sheets were used: PLSS Section Data; Civil Jurisdiction Summary Data; and County Summary Data (Appendix).

PLSS Section Data Sheet: One (1) PLSS Section Data sheet was used for each section located on a photo/acetate. Generally, 1-2 PLSS sections are located on a photo, however, up to four (4) sections per photo were recorded. Section level data sheets record photo documentation including photo year, photo number, county and community(ies) covered, and complete PLSS section location. Also recorded were number of residential, commercial, industrial and institutional structures (1992), area of land use by type, linear distance of sea walls and revetments, and the number of groins and non-flow-through docks.

<u>Civil Jurisdiction Summary Data Sheet</u>: This tally sheet summarizes the data for all PLSS section sheets found within each township, village or city. The sheet records photo year, county, name of civil jurisdiction, a complete listing of PLSS sections included in the summary, as well as all land use, shoreline and structure count data discussed above.

County Summary Data Sheet: The County Summary sheet summarizes all data for the towns, villages and cities located within the county. Documented information includes photo year, county name, an alphabetical listing of all civil jurisdictions within the county, and a summary of all land use, shoreline and

LIMITATIONS AND SOURCES OF ERROR

The U.S. Army Corps of Engineers contracted for aerial photography of the Wisconsin portion of the Lake Michigan shoreline on April 21, 1978 and May 19, 1992. Both sets of photos are 1:6000 scale and panchromatic color, however, the 1978 photos are "leaves-off" while the 1992 photos are "leaves-on."

Copies of the original stereo photos (1:6000 scale) were not available for this study. Instead, enlargements (1:2400 scale) of the original photos were borrowed from Corps district offices in Green Bay and Waukesha. The enlargements provided photographic coverage only, not stereo coverage. Normally, for a project of this magnitude, photos would have been taken to meet the specific objectives of the study. The enlarged photos used for this project present limitations and introduce error beyond what would be reported with original photos flown specifically for this study. Limitations and errors associated with the photographs used are discussed below. Also presented below is discussion regarding methodological inconsistencies.

The following discussion of Limitations and Sources of Error is presented in an attempt to provide the reader a basic understanding of the issues. Any section of the discussion could apply to any of the results reported below. The Results sections of this report present findings without any comprehensive attempt to explain anomalies within, or between, the photo study years (1978 and 1992).

Photo Scale and Enlargements

All vertical aerial photographs not ratioed (enlarged or reduced to a common average scale) or rectified (common tilt/tip corrected to a horizontal reference plane) inherently are scale inaccurate. The original USACE photos (1978 and 1992) were not ratioed or rectified, therefore, their scale varies relative to topographic changes of the coastal zone, tip/tilt of the camera and changing elevation of the camera (aircraft). Enlargements of the original photos simply accentuate the inaccuracies found on the original photos.

Area and linear measurements taken off of the USACE enlarged photos reflect the inaccuracies inherent in those photos. Simple tests of shoreline distances for numerous PLSS sections within each county were conducted to establish linear accuracies of the photos. USGS topo sheets at 1:24000 scale were used to establish base shoreline distance measurements against which photo (1978 and 1992) shoreline distance measurements could be compared. No systematic errors were detected for the 1978 photos. However, only one (1) of 21 tests of the 1992 photos varied in the positive direction from USGS measurements. The remaining 20 tests varied in the negative direction and ranged from -0.8% to -13.1%. The range of error, for 1978 was -5.3% to +9.6%, while the range of error for 1992 was -13.1% to +1.9% (see Table 1 page 17). Without a test of error for each photo used, there is no

means to judge the direction or the amount of error relative to statistics associated with each photo. However, given the range of error found for the 1978 and 1992 photos, it is possible that 1,000 acres (405 ha) (actual) of coastal zone area could be reported as 1,096 acres (444 ha) in 1978 and 869 acres (352 ha) in 1992, a 227 acre (92 ha) difference.

"Leaves-On" Versus "Leaves-Off" Aerial Photography

There are distinct advantages and disadvantages of both "leaves-on" and "leaves-off" aerial photography. However, given the goals of this project, the 1978 "leaves-off" photography offers important advantages over the 1992 "leaves-on" photography. Vegetation in leaf can hide the details of built structures, including buildings and shoreline modifications. Roads can be hidden under tree crowns, as well as portions of lots landscaped and managed as residential land. Leaved canopies increase the effect of shadows. Shadows mask ground, understory and structural information leading to inaccurate interpretation. Land uses and/or structures hidden under the canopy of vegetation or masked by shadows can be underestimated in area, length or count. Land use types particularly affected (underestimated) are single family residential and wetland.

Stereo Versus Photographic Coverage

Both the 1978 and 1992 photo sets were taken to capture stereo (3-D) coverage of the Lake Michigan coastal area. This means that adjacent photos overlap approximately 60%. Stated another way, 60% of the shoreland area located on one photo also is located on an adjacent photo. The shoreland common to adjacent photos is "seen" from two different perspectives which allows stereo viewing (using a stereoscope).

The enlarged photos borrowed from USACE for this study represent photographic coverage only, or every other photo taken of shoreland. While photo (2-D) coverage at large scales can be used to interpret accurately many land use types (agricultural and most urban land), the lack of stereo viewing makes difficult the identification of wetland types and the exact location of bluff lines. Stereo viewing generally would have increased the interpretive accuracy of most land use, structural and shoreline features.

Incomplete Photo Coverage

For this study, the coastal zone is defined as a 1000' strip of land adjacent and parallel to the shoreline. Occasionally, photo coverage did not include all shoreland within 1000' of the water. As a result, total land area is underrepresented, the exact land use types not covered are not known. In such cases, the area not captured on a particular photo was estimated by

reference and comparison to coverage photos of the other flight year.

Missing Photo Coverage

Occasionally, photo coverage was missing from the USACE photo library. In such cases, as described above, coverage area missing was estimated by reference to photos of the other flight year. However, the exact land use types and shoreline features not represented on photos remain unknown.

Location of 1000' Coastal Zone Boundary

On each photo set, 1978 and 1992, a boundary line was drawn representing the 1000' coastal zone parallel to the shoreline. This line was located by scribing a landward line parallel to the line defined by the shoreline (where water meets land). The landward extent of the boundary line is a function of shoreline location, which in turn, is dependent on the water elevation of Lake Michigan. USACE (1978, 1992) reports that in April of 1978 Lake Michigan water elevation was about 578.4 feet (176.3 meters) and about 579.16 feet (176.5 meters) in May, 1992. The nine (9) inch difference in water elevation, while seemingly insignificant, could have shifted substantially landward the shoreline in extremely low slope beach or mud flat areas. The result of such a shift would be inclusion of inland areas NOT included in the 1978 coastal zone.

Lack of Beach Type in Classification Scheme

The width or extent of beach is dependent on slope of an area and water elevation. Since changes in the area of beach likely would reflect more the differences in 1978 and 1992 water levels (9 inches higher in 1992) than actual losses/gains due to erosion or development, no beach type was included in the study.

The lack of a beach type does affect measurement of area within the 1000' coastal zone. The landward extent of the coastal zone is 1000' from the <u>shoreline</u>. Any beach area lies between the shoreline and the base of the bluff, however area measurements of land use types were made only for those types lying between the base of the bluff and the interior boundary of the coastal zone. In most cases, beach strips represent only about five (5) acres per photo.

Positional Changes to the Shoreline: Natural vs. Urban Development

As discussed above, the landward extent of the 1000' coastal boundary is dependent on the location of the shoreline. Natural changes to shoreline position include both water elevation and erosion/deposition of soil. Filling of coastal waters to accommodate urban development artificially changes shoreline

location. In such cases, not only does the shoreline move "offshore," the interior coastal zone boundary line shifts toward the water. This "shift" in coastal boundaries skews area measurement. For example, in 1978 assume the coastal zone in an area to be all residential and that by 1992 100 acres of lake water is filled to develop commercial land. A "lakeward" shift in the location of the shoreline will occur due to the land filled for commercial use. However, this "shift" in the shoreline created by the filled commercial site also will result in a shift toward the water of the interior coastal zone boundary. The effect of the latter shift will be that 100 acres of residential land will not be included as part of the 1992 coastal zone. In such a case, the "raw' statistics misleadingly suggest that 100 acres of residential land use were eliminated to make room for 100 acres of commercial use.

RESULTS

Marinette County Statistics

Marinette County communities lying within the Lake Michigan coastal zone include the township of Peshtigo and the city of Marinette. The area measured within the coastal zone of Marinette County was 1,759 acres (712 ha) in 1978 and 1,644 acres (666 ha) in 1992. This represents a difference of 155 acres (46 ha) or 8.8%. The discrepancy likely is the result of errors inherent in the enlarged aerial photos, as discussed on pages 12 through 15. Using USGS maps as control, tests were conducted on the linear accuracy of the Marinette County photos. Results of tests applied to the 1992 photos indicate close agreement (-1.7%) with USGS measurements. However, results of tests applied to the 1978 photos indicate an error of +9.6%.

Statistical summaries for Marinette County and all communities included in this study are located in the Appendix. Summary data sheets present land use types by area, structural counts by type (1992), shoreline modification types by length, and a count of shoreline structures by type. Data were collected at the PLSS section level. While the section level data sheets are not included in this report, copies are available upon written request.

Residential Land

Within the coastal zone of Marinette County, 831 residential structures were identified on 388 acres (157 ha) of land. Of the total were 541 residential units (single family or duplexes), 122 detached garages, 162 sheds and (6) barns. Since the 1992 photos are "leaves-on," these numbers likely underestimate the actual number of structures and area devoted to residential uses. In 1978, 372 acres (151 ha) of residential land were measured.

Table 1. County Results of Linear Accuracy Tests

Percent Deviation From USGS Base Map Measurements

County	1978 Enlarged Photos (1:2400)	1992 Enlarged Photos (1:2400)
Brown	-0.4% 0.03%	-8.5% -5.5%
Door	1.3% 3.9%	-1.1% -3.6%
Kenosha	-2.5% 3.1%	-9.0% -1.6%
Kewaunee	-1.5% 2.1%	-5.4% -9.6%
Manitowoc	-1.7% 2.0%	-6.4% -7.4%
Marinette (one test)	9.6%	-1.7%
Milwaukee	-4.9% -5.3%	-6.9% 1.9%
Oconto	2.9% 8.5%	-10.8% -13.1%
Ozaukee	0.2% 1.3%	-5.7% -4.4%
Racine	-3.0% 2.2%	-5.0% -0.8%
Sheboygan	-2.5% 4.6%	-1.2% -3.0%
Mean	0.95%	- 5.18%
Range	-5.3% to 9.6%	-13.1% to 1.9%

Commercial and Industrial Land

Commercial land represented 31 acres (12.5 ha) in 1978 and 35 acres (14 ha) in 1992. Twenty-one (21) commercial structures were noted within the coastal zone.

Industrial land covered 9.5 acres (3.8 ha) and 8.7 acres (3.5 ha) in 1978 and 1992, respectively. Photo scale could account for the reported .8 acre (.3 ha) loss.

Transportation Land

Four (4) structures were located on 15 acres (6 ha) of transportation land in 1992. In 1978, about (3) acres (1.2 ha) of transportation land were reported.

Agricultural and Natural Land

Overall, 139 acres (56 ha) of agricultural and natural lands were reported lost from 1978 to 1992, a trend that continues nationally. Land actively being cultivated remained nearly stable. Abandoned fields decreased in area by 52 acres (21 ha) while forest land increased by 10 acres (4 ha). Such a trend would be expected, given farmland abandonment.

would be expected, given farmland abandonment.

Also of note is a 124 acre (50 ha) decline of wetland types. The loss could be actual and attributed to both urban development and the nine (9) inch rise in Lake Michigan water level. However, a portion of the loss could be attributed to the underestimation of wetlands while using "leaves-on" photos.

Open and Other Lands

Open and other land uses remained stable over the study period. Minor losses of area were noted in both the urban open lot and outdoor recreation types.

Shoreline Modifications

Ostensibly, sea walls and revetments are used to protect shorelines from erosion. Significant increases of both types of structures were reported. In 1978, 1,723 feet (525 m) of sea wall were reported compared to 2,954 feet (901 m) in 1992, representing an increase of 1,231 feet (375 m). However, far more significant is the 14,923 foot (4,550 m), 130% increase in revetment development since 1978. Shoreline revetment was measured at 11,447 feet (3,490 m) in 1978 and 26,370 feet (8,040 m) in 1992.

Results by Community

City of Marinette

Land within Marinette's coastal zone was measured at 234 acres (95 ha) in 1978 and 213 acres (86 ha) in 1992. The source of the difference (21 acres, 8.5 ha) could be photo scale anomalies as discussed above.

In 1992, 252 residential structures were located on 63 acres (25.5 ha) of land. Most of these structures (186) were single family or duplex. In 1978, 53 acres (21 ha) of residential land were reported.

Commercial area increased by 6.3 acres (2.6 ha) over the study period, the most significant change being a 5.4 acre (2.2 ha) increase in business district. Results indicate that industrial park land remained virtually unchanged.

No transportation land was tallied in 1978. However, over 12 acres (4.9 ha) were noted for 1992, all dedicated to boat landing.

Agricultural and natural areas decreased from 141 acres (57 ha) in 1978 to 101 acres (41 ha) in 1992. Forest land declined by 14 acres (5.7 ha) or 51%.

Wetlands lost the most area of any type within the natural lands category, from 100 acres (41 ha) in 1978 to 62 acres (25 ha) in 1992.

Two open/other land types showed change during the period studied. Urban open lot areas decreased from (4) acres (1.6 ha) in 1978 to 1.5 acres (.6 ha) in 1992, suggesting the process of infilling is occurring along near-shore lots. The outdoor recreation type also decreased from 8.9 acres (3.6 ha) in 1978 to (3) acres (1.2 ha) in 1992.

From 1978 to 1992, significant shoreline modification has occurred within the city. Sea wall construction increased by 528 feet (161 m) or 194%, from 272 feet (83 m) to 800 feet (244 m). Likewise, revetment construction increased from 2,697 feet (822 m) to 6,472 feet (1,973 m), an increase of 3,775 feet (1,151 m) or 140%.

No groins or non-flow-through docks were recorded for either study year.

Town of Peshtigo

Coastal zone area within the township was measured at 1,525 acres (618 ha) in 1978 and 1,431 acres (580 ha) in 1992, a difference of 38 acres (15.4 ha). The town of Peshtigo was one of those tested for linear accuracy of photo coverage. Using USGS maps at 1:24000, measurements taken from the 1978 photos deviated by +9.6% from the USGS basis. The 1992 photos deviated by only -1.7% from the USGS basis.

In 1992, a total of 579 residential structures were identified on 325 acres (132 ha) of residential land. Of these, 355 were of single family/duplex type.

In 1992, eight (8) commercial structures were located on 12.4 acres (5 ha) of commercial land. The total area represents a modest decrease from 1978. No industrial land was identified for either study year. Land devoted to transportation virtually remained unchanged at just under (3) acres (1.2 ha) for each study year.

Agricultural and natural areas decreased from 1,148 acres (465 ha) to 1,050 acres (425 ha) for the period studied. Within the category changes include a 54 acre (22 ha) decrease in abandoned field and a 25 acre (10 ha) increase in forest land. Wetlands lost 86 acres (35 ha), dropping from 786 acres (319 ha) in 1978 to 700 acres (283 ha) in 1992.

Total open and other lands remained unchanged over the study period.

Shoreline modifications increased significantly during the 14 year period studied. Sea walls increased by 703 feet (214 m) during the period. However, revetment construction increased considerably, from 8,750 feet (2,668 m) to 19,898 feet (6,066 m) or by 11,148 feet (3,399 m).

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APPENDIX

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

County Summary Data Sheet

Year: 1978

County: Marinette

Coastal Civil Jurisdiction included in summary (in alphabetical

order).

City of Marinette
Town of Peshtigo

asper care ou construir se su su su construir se su construir se su su construir se su constru	LAND USE C	ATEGOR	<u>IES</u>		
sales development security of the security of	A Committee of the second seco	a	w * . **		rea
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11 Residential			<i>J</i> *	Service Services	i mađona
111 Res. units				- 1-	
garages	·- 				
sheds		1		1	1
garages		1			
sheds		401		,	150
113 Res. units	-	431 98	 	371	150
garages sheds		134			
barns		2			
115 Res. units					: .
garages sheds		·			
Sileus	Subtotal	667	-	373	151
12 Commercial					
•					
121 Central Bus			· · · · · · · · · · · · · ·		
122 Shopping Ce	nter/Mall	10	 	30	
124 Neighborhoo	d Business Dist	78		<u>30</u> _	12 <1
120 1113010401011	Subtotal	18		31	12
13 Industrial					
138 Industrial	Park	1		10	4

Area Acres Hectares

of structures

	# of struct	ures <u>Acres</u>	<u>Hectares</u>
14 Mary an ambabian			
14 Transportation			
141 Air Transportation			
142 Pail Transportation			
142 Rail Transportation			
143 1 Drivate Marina			
143.1 Private Marina	4	3	1
143.2 Fubile Doct Danuing _		_	
144 Highways 145 Communications			
146 Utilities	,		
146 Utilities 147 Sewage Treatment Plant			
147 Sewaye Treatment Flant 148 Landfill		· · · · · · · · · · · · · · · · · · ·	
Subtotal	1	3	1
Japeoeal		•	*
17 Extractive			
171 Open Pit			
172 Underground			· · · · · · · · · · · · · · · · · · ·
173 1/4 1			
179 Other Extractive			
Subtot	tal		
The state of the s			
18 Agricultural and Natural		$\int_{\mathbb{R}^2} d^3 x$	y sign of the grant of the gran
101 NP Nordanad Field		07	. 20
181 AF Abandoned Field 182 AG Agriculture Active		42	17
183 F Forest		211	<u> </u>
184 H Heath		12	5
185 OW Open Water	<u></u>	43	17
186 RL Rock Ledge	· · · · · · · · · · · · · · · · · · ·		
187 SL Slump Zone		• •	
188 WT Wetland		986	359
Subtotal		1290	522
19 Open Land, Other		A STATE OF THE STA	
			. 😯
191 Outdoor-Public Assembly	<i></i>		4 all a la constitución de la cons
192 Urban Open Lots		12	5
193 Outdoor Recreation	4	42	17
194 Cemeteries			
Subtotal	4	55	22
The middle right of the second			
· · · · · · · · · · · · · · · · · · ·		Total Acres	
200		Total Hecta	res 712
Shoreline Modifications		τ.	inear
SHOTETTHE MOUTTICACTORS		Feet_	Meters
195 Sea Walls		1723	<u>Meters</u> 525
196 Revetments		11447	
197 Groins	<u></u>	# of Groins	
198 Dock Non-Flow-Through			
The poor Holl-Lion-Ilitordit		A OT DOCKS	

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

County Summary Data Sheet

Year: 1992

County: Marinette

Coastal Civil Jurisdiction included in summary (in alphabetical

order).

City of Marinette Town of Peshtigo

LAND USE CATEGORIES

	•	# of structures	Ar Acres	ea Hectares
		# Of Structures	ACLES	nectares
11 Residential				
111 Res. units garages sheds				
112 Res. units garages sheds				
113 Res. units		541	388	157
garages		122		
sheds		162		
barns		6		
115 Res. units garages sheds		444		
Silead	Subtotal	831	388	157
12 Commercial				
121 Central Bus 122 Shopping Ce	nter/Mall _			
124 Neighborhoo	d Business	Dist	34	14
126 Institution	al	1	2	1
	Subtotal	. 21	35	14
13 Industrial				
138 Industrial	Park		9	4

Area

	# of structures	Acres	<u>Hectares</u>
14 Transportation			
141 Air Transportation _			
142 Rall Transportation _			
143 water Transportation			
143.1 Private Marina			
143.2 Public Boat Landing	/ <u> </u>	<u> 15</u>	66
144 Highways 145 Communications			
145 Communications			
147 Sewage Treatment Plan	it		
148 Landfill	4		
Subtotal	4	15	6
17 Extractive			
171 Open Pit	81, co		
172 Underground			
173 Well			
179 Other Extractive			
	otal		
18 Agricultural and Natural	=		
404 38 31 3 3 82 .3 3	•	4=	1.0
181 AF Abandoned Field		45	18
182 AG Agriculture Active		48	<u>19</u> 90
183 F Forest		<u> </u>	12
184 H Heath 185 OW Open Water			18
186 RL Rock Ledge		43	10 1
187 SL Slump Zone			
188 WT Wetland		762	309
Subtotal		1151	466
Bubcocar		1131	400
19 Open Land, Other			
191 Outdoor-Public Assemb	οlv		
192 Urban Open Lots		8	3
193 Outdoor Recreation		38	16
194 Cemeteries		•	
Subtotal		46	19
	m _e -	tal Acres	1644
		tal Hectares	
	10	car necestes	360
Shoreline Modifications		Line	ar
		<u>Feet</u>	Meters
195 Sea Walls		2954	901
196 Revetments		26370	8040
197 Groins		Groins	
198 Dock Non-Flow-Through		Docks	

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

Civil Jurisdiction Summary Data Sheet

Year: 1978

County: Marinette
Township, Village or City name: City of Marinette
PLSS section data sheets <u>included in summary</u> (give full

description):

T30N R24E SEC 4 SEC 8 SEC 9

SEC 17

LAND USE CATEGORIES

			of atmostures	Ar	
		ž	of structures	Acres	<u> Hectares</u>
11 Re:	sidential			e en	•
111	Res. units		· · · · · · · · · · · · · · · · · · ·	* * *	
	garages				
	sheds				
	Res. units				
	garages				
117	sheds Res. units	. —————————————————————————————————————	78	53	- 22
	garages		<u> </u>		
	sheds		10		· · · · · · · · · · · · · · · · · · ·
	barns		,		
115	Res. units				
	garages				
	sheds				
		Subtotal	99	53	22
12 Co	mmercial	•			
121		siness Dist			
	Shopping Ce	enter/Mall			······································
122		d Bucinoce Di	st 6	16	7
122 124	Neighborhoo				
122 124	Neighborhoo Institution	nal		1	<1
122 124			6	<u>1</u> 17	< <u>1</u> 7
122 124 126		nal			

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

Civil Jurisdiction Summary Data Sheet

Year: 1992

County: Marinette

Township, Village or City name: City of Marinette PLSS section data sheets included in summary (give full

description):

T30N R24E SEC 4 SEC 8 SEC 9

SEC 17

LAND USE CATEGORIES

			Ar	·ea
		# of structures	Acres	<u> Hectares</u>
11 Residential				
111 Res. units garages sheds				
112 Res. units garages sheds				
113 Res. units		186	63	26
garages		32		
sheds		34		
barns 115 Res. units				
garages sheds				
	Subtotal	252	63	26
12 Commercial 121 Central Bus	iness Dist			
122 Shopping Ce				
124 Neighborhoo	d Business	Dist <u>12</u>	21	9
126 Institution	al	1	22	1
	Subtotal	13	23	9
13 Industrial				
138 Industrial	Park	1	9	4

Area

of structures Acres Hectares 14 Transportation 141 Air Transportation 142 Rail Transportation 143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries Subtotal Subtotal 5 2
141 Air Transportation 142 Rail Transportation 143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water 185 CW Open Water 186 RL Rock Ledge 187 RC
141 Air Transportation 142 Rail Transportation 143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water 41 41 41 41 41 41 41 4
141 Air Transportation 142 Rail Transportation 143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water 41 41 41 41 41 41 41 4
143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 7 185 OW Open Water 41 41 41 41 41 41 41 4
143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 7 185 OW Open Water 41 41 41 41 41 41 41 4
143 Water Transportation 143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 7 185 OW Open Water 41 41 41 41 41 41 41 4
143.1 Private Marina 143.2 Public Boat Landing 2 12 5 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 181 AF Abandoned Field 7 3 182 AG Agricultural and Natural 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water < 1 13 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant 148 Landfill Subtotal 2 12 5 17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 185 OW Open Water 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
145
146 Utilities
147 Sewage Treatment Plant
Subtotal 2 12 5
Subtotal 2 12 5
17 Extractive 171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal
171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water < <1 <1 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water < <1 <1 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
171 Open Pit 172 Underground 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water < <1 <1 186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
173 Well 179 Other Extractive Subtotal
173 Well 179 Other Extractive Subtotal
173 Well 179 Other Extractive Subtotal
179 Other Extractive Subtotal
Subtotal 18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 13 5 184 H Heath 18 7 7 7 7 7 7 7 7 7
18 Agricultural and Natural 181 AF Abandoned Field 7 3 182 AG Agriculture Active 13 5 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water <1
181 AF Abandoned Field 7 3 182 AG Agriculture Active
181 AF Abandoned Field 7 3 182 AG Agriculture Active
182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water <1
182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water <1
182 AG Agriculture Active 183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water <1
183 F Forest 13 5 184 H Heath 18 7 185 OW Open Water <1
184 H Heath 18 7 185 OW Open Water <1
185 OW Open Water <1
186 RL Rock Ledge 187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 101 41 191 Outdoor-Public Assembly 2 1 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 191 Outdoor-Public Assembly 2 1 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
187 SL Slump Zone 188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 191 Outdoor-Public Assembly 2 1 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
188 WT Wetland 62 25 Subtotal 101 41 19 Open Land, Other 2 1 191 Outdoor-Public Assembly 2 1 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
Subtotal 101 41 19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
19 Open Land, Other 191 Outdoor-Public Assembly 192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
191 Outdoor-Public Assembly
191 Outdoor-Public Assembly
192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
192 Urban Open Lots 2 1 193 Outdoor Recreation 3 1 194 Cemeteries
193 Outdoor Recreation3 1
194 Cemeteries
Total Acres 213
Total Hectares 86
<u>Shoreline Modifications</u> Linear
The transfer of the transfer o
<u>Feet Meters</u>
195 Sea Walls
195 Sea Walls 800 244
195 Sea Walls 800 244 196 Revetments 6472 1973
195 Sea Walls 800 244

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

Civil Jurisdiction Summary Data Sheet

Year: 1978 County: Marinett Township, Village PLSS section data description):	or City na	me: Town of Pesh luded in summary	tigo (give full	
SE SE SE SE SE SE	C 14 C 15 C 16 C 19 C 20 C 21 C 22 C 23 C 24	T29N R24E SEC 6 SEC 7 SEC 1 T30N R24E SEC 1 SEC 1 SEC 1 SEC 2 SEC 3 SEC 3	8 7 8 9 0	
The state of the s	LAND	USE CATEGORIES	Ar	ea
		# of structures	Acres	Hectares
11 Residential			•	والمراكب المستعاد
111 Res. units garages sheds 112 Res. units		1		1
garages		1		
sheds				
113 Res. units	-	353	318	129
garages sheds		87 124		
barns		2		
115 Res. units garages sheds				
•	Subtotal	568	319	129
12 Commercial 121 Central Bus				
122 Shopping Ce 124 Neighborhoo	nter/Mall _	Diet 12	1.4	
124 Neighborhoo 126 Institution		Dist 12	14	6
	Subtotal	12	14	6
13 Industrial	e e e e e e e e e e e e e e e e e e e	en de la companya de		
138 Industrial	Park		· · · · · · · · · · · · · · · · · · ·	

Area # of structures Acres Hectares 14 Transportation 141 Air Transportation___ 142 Rail Transportation _ 143 Water Transportation 143.1 Private Marina _ 143.2 Public Boat Landing _____1 ___3 144 Highways 145 Communications 146 Utilities 147 Sewage Treatment Plant _____ 148 Landfill Subtotal 17 Extractive 171 Open Pit 172 Underground _____ 173 Well 179 Other Extractive Subtotal 18 Agricultural and Natural 42 ... 183 F Forest 183 184 H Heath 187 SL Slump Zone 188 WT Wetland 786 319 Subtotal 1148 465 e e e e e 19 Open Land, Other 191 Outdoor-Public Assembly ____ 192 Urban Open Lots _____ 8 193 Outdoor Recreation 2 33 194 Cemeteries Subtotal 17 Total Acres
Total Hectares 1525 61.8 Shoreline Modifications Linear Feet Meters 1451 195 Sea Walls 442 8750 196 Revetments

197 Groins # of Groins
198 Dock Non-Flow-Through # of Docks

Lake Michigan Coastal Development Inventory Project: 1978 - 1992

Civil Jurisdiction Summary Data Sheet

Year: 1992 County: Marinett Township, Village PLSS section data description):	or City name:	Town of Peshti in summary (igo jive full	
T29N R23E SE	_ ·	9N R24E SEC 6		
	C 14	SEC 7		
	C 15	SEC 18		
		ON R24E SEC 17		
	C 19	SEC 18		
	C 20	SEC 19		
	C 21 C 22	SEC 20 SEC 30		
	C 22 C 23	SEC 30		
	C 24	SEC 31		
SE		CATEGORIES		
	<u> </u>		Ar	ea
	# o:	f_structures	Acres	Hectares
11 Residential 111 Res. units garages sheds 112 Res. units garages sheds 113 Res. units garages sheds 115 Res. units garages sheds barns 115 Res. units garages sheds		6	325	
	Subtotal	579	325	131
12 Commercial 121 Central Bus	iness Dist			
122 Shopping Ce	nter/Mall			
124 Neighborhoo	d Business Dist	8	12	5
126 Institution	al			
	Subtotal	8	12	5
13 Industrial				
138 Industrial	Park			

of structures

	# of structure:	s <u>Acres</u>	<u>Hectares</u>
14 Transportation			
444 Jin Maranananhahian			
141 Air Transportation			
142 Rail Transportation			
143 Water Transportation _			
143.1 Private Marina			
143.2 Public Boat Landing		3	1
144 Highways 145 Communications			
145 Communications			
146 Utilities 147 Sewage Treatment Plant			
148 Landfill Subtotal	2		
Subtotal	2	3	1
17 Extractive			
171 Open Pit			
171 Open Pit 172 Underground			
173 Well			
179 Other Extractive			
Subto	tal		
18 Agricultural and Natural			
181 AF Abandoned Field		38	15
182 AG Agriculture Active		48	19
183 F Forest		208	84
184 H Heath		12	5
185 OW Open Water		43	17
186 RL Rock Ledge		3	1
187 SL Slump Zone			
187 SL Slump Zone 188 WT Wetland		700	283
Subtotal		1050	425
19 Open Land, Other			
191 Outdoor-Public Assembl	y		
192 Urban Open Lots		6	3
193 Outdoor Recreation		35	14
194 Cemeteries			
Subtotal		42	17
	,	Total Acres	1431.
		Total Hectares	
	•		200
Shoreline Modifications		Linear	
		Feet	Meters
195 Sea Walls			657
100 December		19898	6067
107 0		" - 6 - 0	
198 Dock Non-Flow-Through		·# of Docks	
200 Door Holl I Iow Ill Ough		" OF DOCKS	